

## NASA Sample Return Missions: Recovery Operations

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The Utah Test and Training Range (UTTR), southwest of Salt Lake City, Utah, is the site of all NASA unmanned sample return missions. To date these missions include the Genesis solar wind samples (2004) and Stardust cometary and interstellar dust samples (2006). NASA's OSIRIS-REx Mission will return its first asteroid sample at UTTR in 2023.

The reason for recovery operations at UTTR is many fold, but the simple reason is that it is the largest contiguous block of restricted airspace in the continental United States. This airspace covers over 9,000 square kilometers of land and is under the jurisdiction of the U.S. Air Force. Hill Air Force Base (AFB) is responsible for the operation of the range and supports thousands of test and training exercises each year. This valuable test experience coupled with its robust radar tracking assets is another attractive feature of NASA's chosen landing site. Grounding missions due to weather are uncommon, in fact the Hill AFB On-Scene Commander reviewed a sub-set of data earlier in 2017 from the last three years of missions and none were grounded due to weather – just one was delayed by an hour. Temperature lows during their winter months (December, January and February) are typically below freezing which could be attractive for a future cold sample return. The soft clay on the range is of particular interest to sample return capsule (SRC) designers because it offers a landing surface that might save precious spacecraft mass if padding on the SRC is reduced. As a U. S. military base, non-U. S. citizen visitors must be escorted at all times, but this did not deter international Genesis or Stardust team members from participating in recovery operations. However, it does require more planning due to the approval process for foreign visitors.

Two risk items at UTTR are worth noting for future sample return mission managers: (1) the range contains zones where the SRC cannot be recovered. In comparison to the large landing footprint the range offers, these prohibited zones are small but should be factored into a mission's risk posture; and (2) due to the nature of testing conducted on the range, unfired ordnance is a hazard to visitors of the range. For this reason, no one from NASA goes on the range without military escort, and a military On-Scene Commander led both recovery teams during all training and actual recovery events. It is expected that this protocol would be followed for any future sample recovery operation.

Once recovered in the field, UTTR has facilities to accommodate sample assessment. Genesis and Stardust (and OSIRIS-REx in 2023) took advantage of this by setting up a modular ISO Class 7 cleanroom. After initial investigation in Utah, the SRC was flown from the UTTR's military airfield directly to Ellington Field, 12 kilometers from NASA's Johnson Space Center (JSC) where the Curation facility resides. Upon arrival at JSC, the Genesis and Stardust samples were initially assessed and prepped for transfer to their dedicated Curation Facility in an ISO 7 hardware cleanroom. Once transferred to the dedicated Curation Facility (housed within the same building as the hardware cleanroom, these Curation Facilities are ISO Class 4 and 5, respectively); preliminary examination of the samples by the Science Team began.

The excitement from a sample return is hard to predict. Upon arrival at JSC for Genesis and Stardust, the media, science team, fellow JSC scientists and even the surrounding community's interest were overwhelming. This excitement can lead the team to work fast. Try to avoid this and stick with the rehearsed plan. Designate a person or two to talk with outsiders so that the mission team can focus on what's important – protecting the samples.